

Symposium New Methods of Mass Spectrometry and their Applications in the Environmental Sciences (SYMS)

jointly organized by
the Mass Spectrometry Division (MS) and
the Environmental Physics Division (UP)

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Overview of Invited Talks and Sessions

(lecture room A 001)

Invited Talks

SYMS 1.1	Th	10:30–11:00	A 001	Mass spectrometric measurements of atmospheric trace gases and ions — ●FRANK ARNOLD
SYMS 1.2	Th	11:00–11:30	A 001	What do cosmogenic radionuclides in polar ice cores tell us? — ●JUERG BEER
SYMS 1.3	Th	11:30–12:00	A 001	Aerosol-Massenspektrometrie: Techniken, Möglichkeiten, Grenzen — ●FRANK DREWNICK
SYMS 1.4	Th	12:00–12:30	A 001	Organic compounds in the atmosphere: insights from Isotope Mass Spectrometry — ●ASTRID KIENDLER-SCHARR, IULIA GENSCH, THORSTEN HOHAUS, BEATRIX KAMMER, WERNER LAUMER
SYMS 2.1	Th	14:00–14:30	A 001	Cosmogenic and anthropogenic radionuclides in the Earth Surface Sciences — ●TIBOR DUNAI
SYMS 2.2	Th	14:30–15:00	A 001	Pushing the limits of high-precision radiocarbon measurements — ●LUKAS WACKER, GEORGES BONANI, IRENA HAJDAS, BERND KROMER, HANS-ARNO SYNAL
SYMS 2.3	Th	15:00–15:30	A 001	Precise and accurate analysis of U-series isotopes by MC-ICPMS — ●DENIS SCHOLZ
SYMS 2.4	Th	15:30–16:00	A 001	Progress of inorganic mass spectrometry in environmental and life sciences — ●J. SABINE BECKER

Sessions

SYMS 1.1–1.4	Th	10:30–12:30	A 001	Session I
SYMS 2.1–2.4	Th	14:00–16:00	A 001	Session II

SYMS 1: Session I

Time: Thursday 10:30–12:30

Location: A 001

Invited Talk SYMS 1.1 Th 10:30 A 001
Mass spectrometric measurements of atmospheric trace gases and ions — ●FRANK ARNOLD — Max-Planck-Institut für Kernphysik, Postfach 103980, 69000 Heidelberg

Mass spectrometric measurements of atmospheric trace gases, ions, and aerosol components have an important role in atmospheric environmental research. This talk reviews trace gas and ion measurements with a focus on recent developments. Measurements carried out on aircraft, on high altitude mountain sites, in ground-level air, in test chambers, in Diesel engine exhaust, and in air influenced by lightning and other electric discharges will be reported. The mass spectrometric instruments employed include linear quadrupole mass filters, ion trap mass spectrometers, chemical ionization mass spectrometers, and ion mass spectrometers.

Invited Talk SYMS 1.2 Th 11:00 A 001
What do cosmogenic radionuclides in polar ice cores tell us? — ●JUERG BEER — Eawag, CH-8600 Dübendorf

The continuous progress in accelerator mass spectrometry during the past decades made it possible to measure cosmogenic radionuclides such as ^{10}Be and ^{36}Cl in polar ice cores with a high temporal resolution of a few years over the past about 100,000 years. This data reveals a large variety of unprecedented information on the long-term variability of the solar activity and the geomagnetic dipole field and on transport processes within the atmosphere. After an overview of the present status new future applications will be discussed.

Invited Talk SYMS 1.3 Th 11:30 A 001
Aerosol-Massenspektrometrie: Techniken, Möglichkeiten, Grenzen — ●FRANK DREWNICK — Max-Planck-Institut für Chemie, Mainz, Deutschland

Massenspektrometrische Methoden eignen sich aufgrund ihrer vielseitigen Anwendungsmöglichkeiten und ihrer hohen Empfindlichkeit hervorragend für die Analyse von Aerosolpartikeln. Insbesondere die direkt-messende (on-line) Aerosol-Massenspektrometrie hat in den vergangenen Jahren eine beachtliche Entwicklung vollzogen und ist zu einer Standardmethode in der Untersuchung atomosphärischer Ae-

rosolpartikel geworden. In nahezu jeder größeren Aerosol Feldmesskampagne wird ein oder mehrere dieser Instrumente eingesetzt um zeitlich hochaufgelöste Informationen über die Zusammensetzung der Aerosolpartikel zu erhalten. Mobile Aerosol-Massenspektrometer werden in Bodenmessstationen, Forschungsflugzeugen und mobilen Laboren betrieben. Je nach Fragestellung wird die Zusammensetzung des Aerosol-Ensembles oder aber die einzelner Partikel untersucht. Häufig können dazu Informationen über die Partikelgrößen bzw. die größenabhängige Komposition erhalten werden. In diesem Übersichtsvortrag wird ein Überblick über moderne Methoden der on-line Aerosol-Massenspektrometrie und ihre Anwendungen gegeben. Die Möglichkeiten dieser Techniken aber auch ihre Grenzen werden diskutiert. Schließlich wird ein Ausblick auf mögliche Entwicklungen und notwendige Verbesserungen auf diesem Gebiet gegeben.

Invited Talk SYMS 1.4 Th 12:00 A 001
Organic compounds in the atmosphere: insights from Isotope Mass Spectrometry — ●ASTRID KIENDLER-SCHARR, IULIA GENSCH, THORSTEN HOHAUS, BEATRIX KAMMER, and WERNER LAUMER — ICG-2: Troposphäre, Forschungszentrum Jülich GmbH, Jülich, Germany

Organic compounds are emitted into the atmosphere from both anthropogenic and biogenic sources. Volatile organic compounds (VOC) undergo photochemical conversion in the atmosphere and serve as precursors for ozone and aerosols. Analyzing the ratio of stable isotopes in atmospheric samples of both gas and particulate phase organics can provide insight into the extent of chemical and physical processing that an air mass has experienced. Oxidation processes in general result in fractionation between the heavy and light isotopes favoring the light isotopes to accumulate in the product whereas the reactant enriches with the heavy isotopes due to the kinetic isotope effect (KIE). As a result, compounds formed from oxidation processes in the atmosphere are isotopically lighter whereas their precursors are enriched with heavy isotopes. After having determined the KIE in laboratory studies it is possible to evaluate the origin of VOCs or their processing in the atmosphere. The talk will summarize the state of the art of isotope mass spectrometry in atmospheric VOC and aerosol studies.

SYMS 2: Session II

Time: Thursday 14:00–16:00

Location: A 001

Invited Talk SYMS 2.1 Th 14:00 A 001
Cosmogenic and anthropogenic radionuclides in the Earth Surface Sciences — ●TIBOR DUNAI — School of Geosciences, University of Edinburgh, UK

Cosmogenic nuclides have become a widely used tool to address scientific questions in Earth surface sciences. Major advances in AMS-technology in the late 1980s have brought analytical sensitivity, accuracy and precision that made application to problems in Earth sciences feasible. In particular, widespread use of in-situ produced cosmogenic nuclides, such as ^{10}Be , ^{26}Al and ^{36}Cl , has revolutionised Earth surface sciences in the last 15 years. The capabilities to quantify the geomorphic stability of surfaces exposed to cosmic rays and to determine long-term erosion rates were quickly adopted to address, and resolve for the first time, a wide range of first-order problems in the fields of geomorphology, glaciology, palaeoclimatology, palaeoseismology, soil science, volcanology and geohazard research. The ongoing innovation in analytical techniques and interpretative tools has further extended the time-range of where AMS-methodology can be usefully applied to Earth Surface sciences. With the emergence of in-situ ^{14}C and ^{53}Mn methodology, and utilization of fallout ^{139}Pu , the entire time-range of Earth Surface processes, present-day to ancient (>10 Ma), can now be addressed using AMS-related methodology. The presentation will provide an overview of applications of these nuclides to Earth Surface sciences, highlighting novel methodological developments.

Invited Talk SYMS 2.2 Th 14:30 A 001
Pushing the limits of high-precision radiocarbon measurements — ●LUKAS WACKER¹, GEORGES BONANI¹, IRENA HAJDAS¹,

BERND KROMER², and HANS-ARNO SYNAL¹ — ¹Ion Beam Physics, Physics Department, ETH Zurich, Switzerland — ²Heidelberg Academy of Sciences, Germany

Accelerator Mass Spectrometry (AMS) is mostly used for radiocarbon dating, because it allows determining efficiently ^{14}C without isobaric or molecular background. While for many years these measurements were performed on large tandem accelerators (3 - 6 MV), this has changed over the last 10 years and compact AMS systems (<500 kV) are now preferably used. The Mini CARbon DAting Systems (MICADAS) developed at ETH Zurich (200 kV) goes beyond what is generally accepted as high-precision radiocarbon measurements and represents the state of the art. The reason for this originates in the compact design that shows more similarities to a stable isotope mass spectrometer than to an accelerator based AMS system.

The perspectives of MICADAS are demonstrated on an example of highest-precision measurements of wood samples for the radiocarbon calibration curve. Inflation in radiocarbon dating is expected, when single compounds isolated by analytical techniques like HPLC or GC can be measured. Unfortunately the isolated material is limited to a few micro-gram. MICADAS is equipped with a gas ion source for the direct measurement of CO_2 and allows for the first time precise routine radiocarbon dating of micro-gram samples. The impact of the new-generation compact radiocarbon dating systems will be discussed.

Invited Talk SYMS 2.3 Th 15:00 A 001
Precise and accurate analysis of U-series isotopes by MC-ICPMS — ●DENIS SCHOLZ — Institut für Geowissenschaften, Johannes-Gutenberg-Universität Mainz, Germany

The reconstruction of past climate variability provides important information for the determination of the magnitude of both temporal and spatial natural climate variability. Furthermore, paleoclimate data provide constraints for climate model simulations and may also be used to validate the predictions of those.

An important issue of paleoclimate reconstruction is the precise determination of the timing and duration of past climate changes. One of the most precise dating methods for the period of the last 600,000 years is Th/U-dating. The application of MC-ICPMS allows both very precise and accurate determination of U-series isotope ratios, high sample throughput, and to work with small sample sizes.

However, the raw isotope ratios measured by MC-ICPMS are affected by several instrumental biases, such as ion-counter-Faraday-cup gain, ion counter darknoise, Faraday cup baseline, peak tailing ("abundance sensitivity") and mass fractionation, which need to be corrected. In this talk I will discuss these various effects and outline appropriate correction methods.

Finally, I will exemplarily show the application of MC-ICPMS Th/U-dating to stalagmites, which are one of the best suited materials for U-series dating, and discuss the implications in terms of past climate variability.

Invited Talk

SYMS 2.4 Th 15:30 A 001

Progress of inorganic mass spectrometry in environmental and life sciences — ●J. SABINE BECKER — Forschungszentrum Jülich

Laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) has become established as a very efficient and sensitive trace and surface analytical technique in geology, material research, environmental and life sciences. We used LA-ICP-MS to produce images for investigating the spatial element distribution as well as the layered structures and inhomogeneities in thin tissue sections (e.g., human and rat brain tissues) to study neurodegenerative diseases or for biomonitoring of toxic metals in animal and plant samples in environmental research with a spatial resolution at micrometre scale. Furthermore, the possibility of the nanometre scale analysis of elements in tissues using a laser microdissection system or the application of the near-field effect in LA-ICP-MS will be discussed. These novel analytical techniques in LA-ICP-MS open up a new challenging path for future applications in the imaging of elements in life sciences and environmental research.